

CLAIMS

1. A Sallen-Key type differential filter circuit, comprising:

an amplifier part, the amplifier part having a positive input, a negative input, a positive output, a negative output,

first and second resistors connected in series with the positive input of the amplifier part, having a first node between said first and second resistors, the second resistor being connected between the first resistor and the positive input of the amplifier part,

third and fourth resistor connected in series with the negative input of the amplifier part, having a second node between said third and fourth resistors, the fourth resistor being connected between the third resistor and the negative input of the amplifier part,

at least one capacitor connected between the positive and negative inputs of the amplifier part,

first and second feedback capacitor connected between the first and second nodes and the positive and negative outputs of the amplifier part,

an input buffer part, the input buffer part having a positive input, a negative input, a positive output, a negative output,

the input buffer part further comprising a first buffer output resistor associated to the positive output of the input buffer part, a second buffer output resistor associated to the negative output of the input buffer part,

wherein

the first and third resistors comprise the first and second buffer output resistors, respectively.

2. The circuit of claim 1, wherein at least one resistor is a variable resistor.

3. The circuit of claim 2, wherein the variable resistor comprises multiple switchable resistors

4. The circuit of claim 3, wherein the switchable resistors are connected in series.

5. The circuit of claim 1, wherein at least one capacitor is a variable capacitor.
6. The circuit of claim 5, wherein the variable capacitor comprises multiple switchable capacitors.
7. The circuit of claim 3, wherein the switching elements are MOSFET transistors.
8. The circuit of claim 1, wherein a required supply voltage of the circuit is not higher than 1.5 V.
9. The circuit of claim 4, wherein the resistors within the variable resistor are connected between a supply voltage and the switch of the subsequent resistor.
10. The circuit of claim 1, wherein said first and second output buffer resistors are connected in series with said first and third resistors, respectively.
11. A filter circuit assembly comprising multiple filter stages, wherein at least one filter stage comprises a filter circuit, the filter circuit comprising
 - an amplifier part, the amplifier part having a positive input, a negative input, a positive output, a negative output,
 - first and second resistors connected in series with the positive input of the amplifier part, having a first node between said first and second resistors, the second resistor being connected between the first resistor and the positive input of the amplifier part,
 - third and fourth resistor connected in series with the negative input of the amplifier part, having a second node between said third and fourth resistors, the fourth resistor being connected between the third resistor and the negative input of the amplifier part,
 - at least one capacitor connected between the positive and negative inputs of the amplifier part,
 - first and second feedback capacitor connected between the first and second nodes and the positive and negative outputs of the amplifier part,

an input buffer part, the input buffer part having a positive input, a negative input, a positive output, a negative output,

the input buffer part further comprising a first buffer output resistor associated to the positive output of the input buffer part, a second buffer output resistor associated to the negative output of the input buffer part,

wherein

the first and third resistors comprise the first and second buffer output resistors, respectively.

12. The circuit assembly of claim 11, wherein at least one resistor is a variable resistor.

13. The circuit assembly of claim 12, wherein the variable resistor comprises multiple switchable resistors

14. The circuit assembly of claim 13, wherein the switchable resistors are connected in series.

15. The circuit assembly of claim 11, wherein at least one capacitor is a variable capacitor.

16. The circuit assembly of claim 15, wherein the variable capacitor comprises multiple switchable capacitors.

17. The circuit assembly of claim 13, wherein the switching elements are MOSFET transistors.

18. The circuit assembly of claim 11, wherein the circuit is implemented on an integrated chip.

19. The circuit assembly of claim 13, wherein resistors within the variable resistor are connected between a V_{DD} voltage and the switch of the subsequent resistor.

20. The circuit assembly of claim 11, wherein said first and second output buffer resistors are connected in series with said first and third resistors, respectively.

21. A filter circuit assembly comprising:

at least one filter stage, said filter stage comprising at least one variable resistor,
a resistor/capacitor (RC) oscillator having an output, the output of the RC oscillator controlling the value of the variable resistor, said RC oscillator further comprising at least one variable resistor, wherein the controlling output of the RC oscillator also controls the value of the variable resistor of the RC oscillator,
wherein the structure of the variable resistor of the filter stage is substantially identical to the structure of the variable resistor of the RC oscillator.

22. The assembly of claim 21, wherein the RC oscillator further comprises an RC digitally controlled oscillator (DCO).

23. The assembly of claim 21, wherein the variable resistors comprise multiple switchable resistors

24. The assembly of claim 21, wherein the substantially identical structure of the variable resistors comprises the connection layout and the value of the respective resistors within the variable resistors.

25. The assembly of claim 23, wherein voltage across the switchable resistor of the RC oscillator is substantially constant, so that a substantially constant current flows through the switchable resistor.

26. The assembly of claim 26, wherein the substantially constant current is mirrored for alternately charging and discharging a capacitor of the RC oscillator.

27. The assembly of claim 21, further comprising
a reference oscillator having an output,

a resistor setting circuit having a first input for receiving the controlling output of the RC oscillator and a second input for receiving said output of the reference oscillator, wherein the controlling output of the resistor setting circuit controls the values of the variable resistors of the filter stage and the RC oscillator.

28. The assembly of claim 27, wherein the controlling output of the RC oscillator delivers a frequency of the RC oscillator.

29. The assembly of claim 28, wherein the frequency of the RC oscillator is a function of the variable resistor of the RC oscillator.

30. The assembly of claim 21, wherein the frequency of the RC oscillator is proportional to the frequency of the filter stage.

31. The assembly of claim 27, wherein the resistor setting circuit is a successive approximation register (SAR) circuit.

32. The assembly of claim 27, wherein the resistor setting circuit adjusts its controlling output as a function of the frequency of the RC oscillator and the frequency of the reference oscillator.

33. The assembly of claim 32, wherein the resistor setting circuit adjusts the values of the variable resistors until the frequency of the RC oscillator and the frequency of the reference oscillator assumes a predetermined proportion.

34. The assembly of claim 21, comprising multiple filter stages.

35. The assembly of claim 34, in which at least one filter stage comprises a filter circuit, the filter circuit comprising

an amplifier part, the amplifier part having a positive input, a negative input, a positive output, a negative output,

first and second resistors connected in series with the positive input of the amplifier part, having a first node between said first and second resistors, the second resistor being connected between the first resistor and the positive input of the amplifier part,

third and fourth resistor connected in series with the negative input of the amplifier part, having a second node between said third and fourth resistors, the fourth resistor being connected between the third resistor and the negative input of the amplifier part,

at least one capacitor connected between the positive and negative inputs of the amplifier part,

first and second feedback capacitor connected between the first and second nodes and the positive and negative outputs of the amplifier part,

an input buffer part, the input buffer part having a positive input, a negative input, a positive output, a negative output,

the input buffer part further comprising a first buffer output resistor associated to the positive output of the input buffer part, a second buffer output resistor associated to the negative output of the input buffer part,

wherein

the first and third resistors comprise the first and second buffer output resistors, respectively.

36. The assembly of claim 34, wherein at least one filter stage comprises a variable capacitor.

37. The assembly of claim 35, wherein the variable capacitor comprises multiple switchable capacitors

38. The assembly of claim 37, wherein the assembly is implemented on a chip.

39. The circuit assembly of claim 35, wherein said first and second output buffer resistors are connected in series with said first and third resistors, respectively.

40. The circuit assembly of claim 21, wherein a required supply voltage of the assembly is not higher than 1.5 V.

41. A method for adjusting the frequency or compensating process parameters of a Sallen-Key type filter having at least one filter stage with variable resistors, the method including the steps of

providing an RC oscillator having an output, said RC oscillator further comprising at least one variable resistor,

controlling the value of the variable resistor of a filter stage with the output of the RC oscillator,

controlling the value of the variable resistor of the RC oscillator with the output of the RC oscillator, and

providing a variable resistor in the RC oscillator, which has a structure substantially identical to the structure of the variable resistor of the filter stage.

42. The method of claim 41, further comprising the step of

providing a reference oscillator having an output,

providing a resistor setting circuit having a first input for receiving the controlling output of the RC oscillator and a second input for receiving said output of the reference oscillator, and a controlling output,

the method further comprising the step of controlling the values of the variable resistors of the filter stage and the RC oscillator with the controlling output of the resistor setting circuit.

43. The method of claim 42, further comprising the step of delivering the frequency of the RC oscillator to the controlling output of the RC oscillator.

44. The method of claim 42, further comprising the step of adjusting the controlling output of the resistor setting circuit as a function of at least one of the following:

- a, the frequency of the RC oscillator
- b, the frequency of the reference oscillator.

45. The method of claim 44, further comprising the step of adjusting the values of the variable resistors until the frequency of the RC oscillator and the frequency of the reference oscillator assumes a predetermined proportion.

46. The method of claim 41, further comprising the step of employing a filter circuit with multiple filter stages, wherein a filter stages comprises

- an amplifier part, the amplifier part having a positive input, a negative input, a positive output, a negative output,

- first and second resistors connected in series with the positive input of the amplifier part, having a first node between said first and second resistors, the second resistor being connected between the first resistor and the positive input of the amplifier part,

- third and fourth resistor connected in series with the negative input of the amplifier part, having a second node between said third and fourth resistors, the fourth resistor being connected between the third resistor and the negative input of the amplifier part,

- at least one capacitor connected between the positive and negative inputs of the amplifier part,

- first and second feedback capacitor connected between the first and second nodes and the positive and negative outputs of the amplifier part, respectively,

- an input buffer part, the input buffer part having a positive input, a negative input, a positive output, a negative output,

- the input buffer part further comprising a first buffer output resistor associated to the positive output of the input buffer part, a second buffer output resistor associated to the negative output of the input buffer part,

the method further including the step of including the value of said first and second buffer output resistors in the value of said first and third resistors, respectively.

47. The method of claim 46, further including the step of connecting said first and second buffer output resistors in series with said first and third resistors.

48. The method of claim 41, further including the step of providing a substantially constant voltage across the variable resistor in the RC oscillator, and thereby generating a substantially constant current flowing through the variable resistor.

49. The method of claim 48, further including the step of mirroring said substantially constant current for alternately charging and discharging a capacitor in the RC oscillator.